(12) UK Patent Application (19) GB (11) 2 366 510 (13) A

(43) Date of A Publication 13.03.2002

(21) Application No 0021907.1

(22) Date of Filing 06.09.2000

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(51) INT CL[7]
A47J 31/40 // A47J 31/06

(52) UK CL (Edition T)
A4E E134 E166

(56) Documents Cited
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EP 0337615 A
WO 99/05036 A
US 4886674 A
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(58) Field of Search
UK CL (Edition R) A4E
INT CL[7] A47J 31/06 31/18 31/40 31/44
Online: EPODOC, WPI, JAPIO

(54) Abstract Title
Methods and apparatus for brewing beverages.

(57) A device for brewing beverages comprises two clamshell clamp sections 1 and 2, lined with a slightly convex layer of silicone elastomer 3 to define a brewing cavity. Placed within the cavity is a brewing sachet 4 containing brewing ingredient 9. The sachet includes an injection nozzle 6, a bottom opening 8 that protrudes from the brewing cavity and a seal 7. The seal is released by heat or moisture generated during brewing. The injectors are arranged to be withdrawn from the cavity when the clamp sections 1 and 2 are opened, to prevent injury.

In use, a sachet is placed within the brewing cavity. Hot water is injected through nozzle 6 via injector (14). The beverage brews within the sachet and is released through opening 8. The elastomer layer 3 allows varying pressures to be exerted on the sachet for example to prevent the release of beverage until a specified time, or to maintain a compacted layer of ingredient within the sachet.

In alternative embodiments the elastomer layer may be replaced by one or more bladders, the bladders being expandable by the introduction of a suitable fluid. The injectors may also directly pierce the sides of the sachet rather than entering through nozzle 6. The sachet opening 8 also has a number of configurations.

FIG. 1

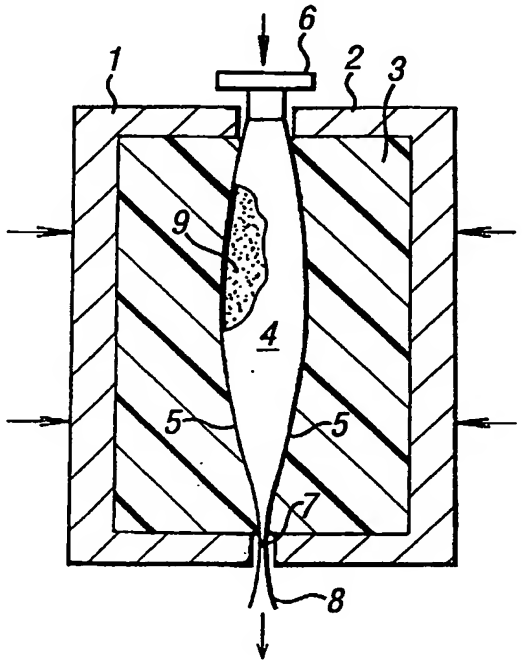

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FIG. 2

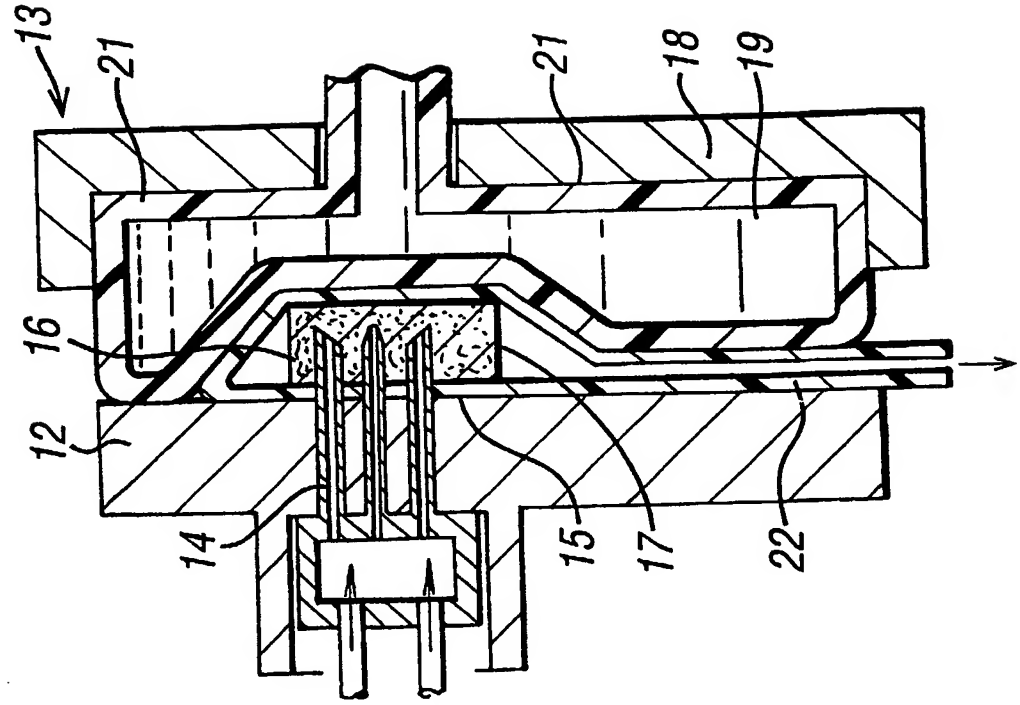


FIG. 1

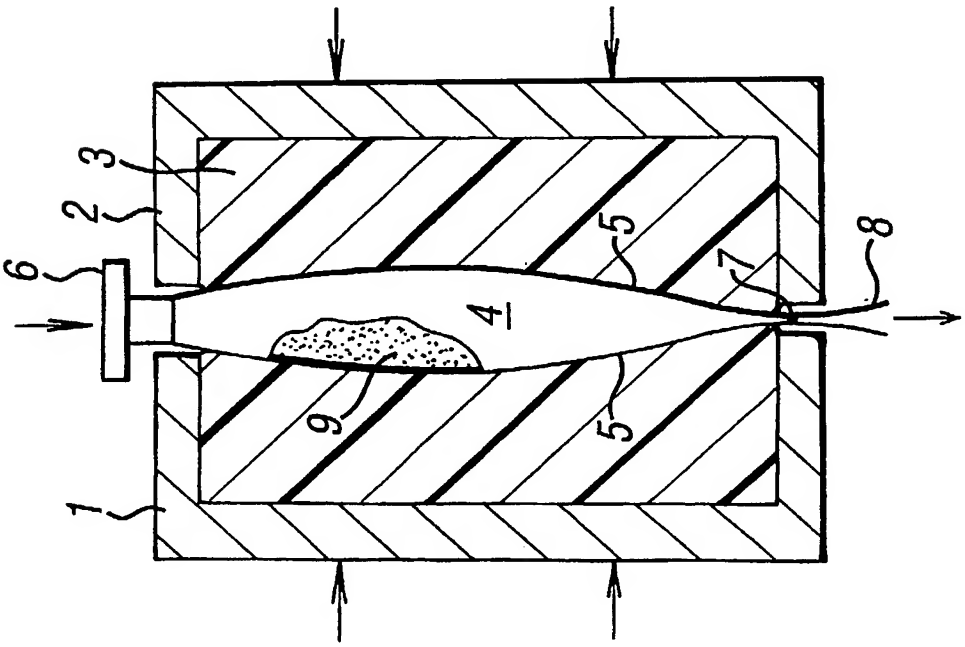


FIG. 3

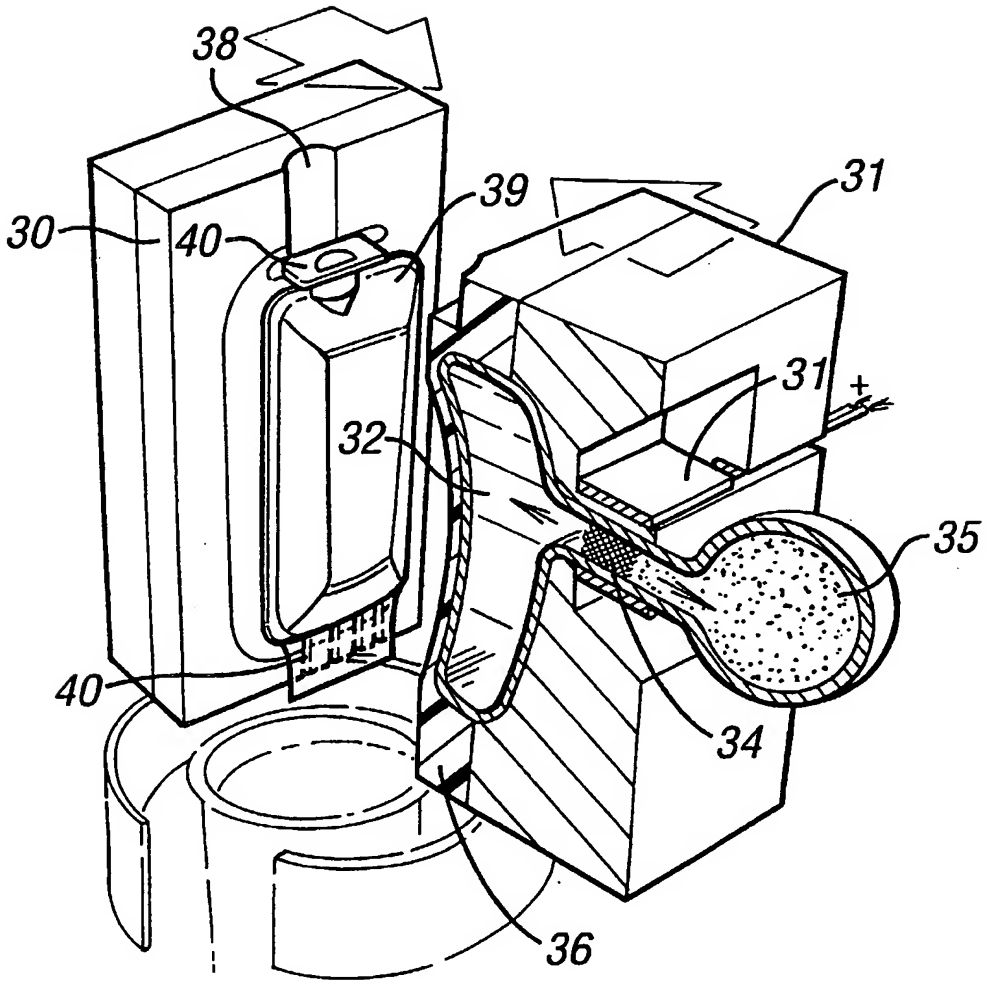


FIG. 5

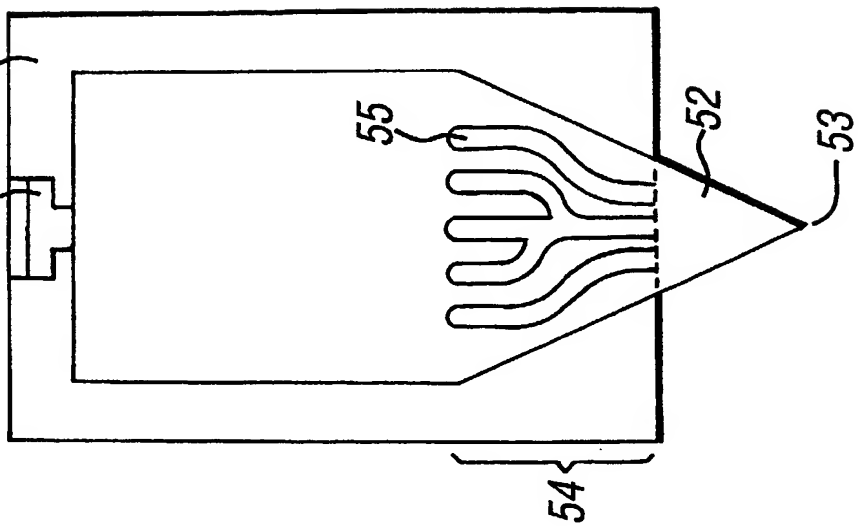
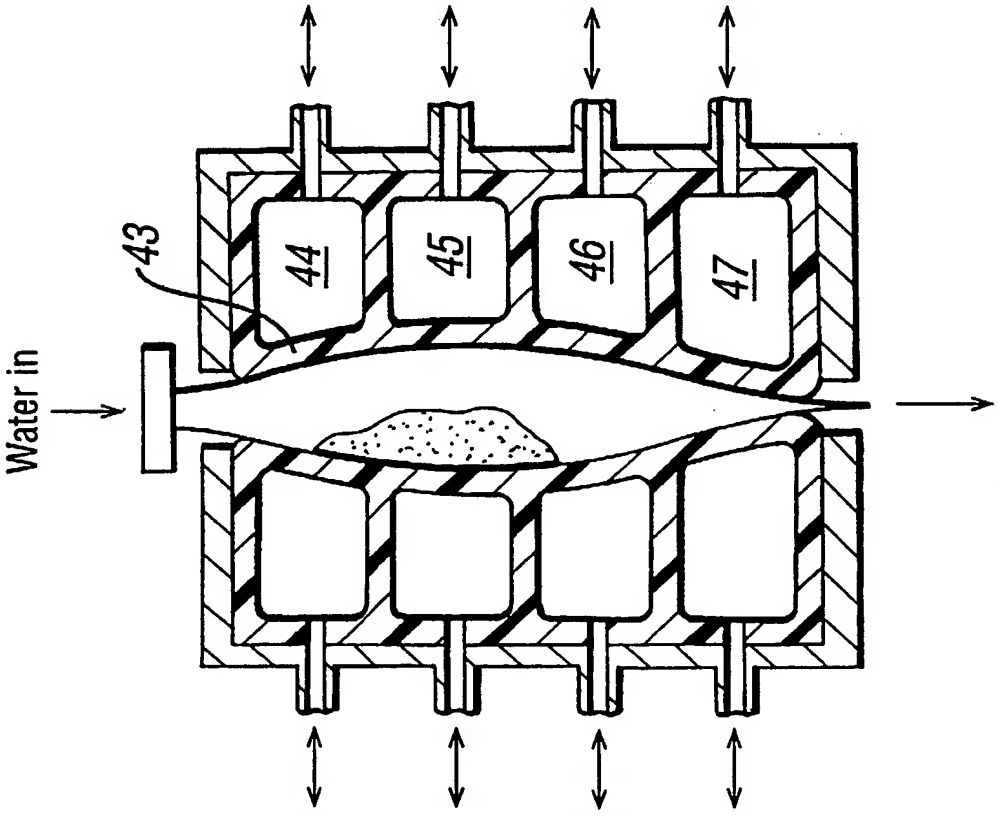


FIG. 4



METHODS AND APPARATUS FOR BREWING BEVERAGES

The present invention relates to an apparatus for brewing beverages such as coffee or tea. The present invention also relates to methods of brewing such beverages, and to beverage sachets for use in such methods.

It is known to brew individual portions of beverages such as a coffee and tea from prepacked individual sachets or capsules containing a single portion of the beverage brewing ingredient such as ground coffee or leaf tea. However, it is difficult to devise a packaging and brewing system that can be adapted to produce a full range of top quality freshly brewed beverages in individual portions, for example from vending installations.

Filter coffee and leaf tea are generally brewed at near-atmospheric pressure, but have different optimum brewing temperatures and times. Espresso coffee is brewed by forcing hot water through a compacted bed of coffee at a pressure of 5-15 bar and a temperature of 90°C. It has not hitherto been possible to brew individual portions of all of these beverages in a single apparatus.

GB-A-2121562, EP-A-0179641 and WO99/05036 describe a beverage brewing system according to which individual portions of beverage brewing ingredients are enclosed in flexible film sachets having an injection nozzle at the top and a seal at the bottom. A filter paper is also provided in a lower part of the sachet. In use, hot water is injected through the nozzle into the sachet. The beverage is brewed inside the sachet, and the seal at the bottom of the sachet is opened either before or during the brewing to allow the beverage to flow out through the bottom of the sachet. This apparatus provides very good quality, freshly brewed filter coffee and leaf tea in individual portions. However, the thin film sachets cannot withstand high brewing pressures inside the sachet, and therefore such sachets have not hitherto been used for brewing espresso coffee.

Furthermore, the sachets need to be formed from a relatively thick sheet materials, for example laminates formed from a layer of metal foil sandwiched

between two thermoplastic films. This is needed in order to provide an oxygen and moisture barrier during storage, as well as to provide the sachets with sufficient strength to withstand the brewing conditions. Such sachets are then difficult to recycle, and contribute to landfill waste. Another difficulty is that the bottom of the sachet may occasionally burst open during brewing in such a way as to spray the user with beverage.

US-A-584189 describes a filter cartridge for brewing individual portions of tea or filter coffee. The cartridge has a self-supporting filter element fitted within a hollow base and containing a beverage brewing ingredient. Hot water is injected through the top of the filter cartridge into the beverage brewing ingredient. This arrangement suffers from similar drawbacks as the sachet of GB-A-2121562.

It is also known to brew individual portions of espresso coffee from individual capsules of ground coffee. The capsules typically contain a portion of ground coffee, tightly compacted in a capsule having a frustoconical or oblate spheroid shape and formed from air- and moisture-impermeable material. The capsule is inserted into a rigid, metal brewing chamber that is normally shaped to fit around the capsule tightly. The brewing chamber has a filter element in its base, means to pierce the underside of the capsule, and means to inject hot water at a pressure of 5-15 bar into the interior of the capsule to brew espresso coffee. Espresso coffee brewing capsules and systems of this type are described, for example, in WO93/17932 and WO94/02059.

A drawback of the existing espresso brewing capsules is that they are adapted for use with conventional espresso machines that have a rigid brewing cavity dimensioned to receive a bed of coffee of specific dimensions, and to apply the necessary pressure to such a bed of coffee. This means that the existing espresso capsule systems are not very flexible, either for varying the amount of coffee in the capsule, or for varying the degree of compaction of the coffee bed during brewing. A further drawback of the existing espresso systems is cross-contamination between the successive brews, since the beverage exiting the

capsule passes through, and therefore contaminates, the base part of the brewing chamber.

EP-A-0521186 describes a capsule containing a compressed beverage brewing ingredient, such as ground coffee, for use in espresso-type machines. The capsule is deformable to assume the shape of the cavity of whichever espresso machine it is used in. This removes the need for a special adapter to adapt existing espresso machines to the exact shape and configuration of the capsule. Unfortunately, it also means that the coffee in the capsule may be insufficiently compacted for optimal espresso coffee brewing. The problem of cross-contamination by successive brews also exists for this configuration.

It is an object of the present invention to provide an improved apparatus for the brewing of beverages from sachets of beverage brewing ingredients.

It is a further object to provide such an apparatus adapted to brew beverages from sachets of beverage brewing ingredients wherein the packages can have varying dimensions and/or may contain varying amounts of the beverage brewing ingredient.

It is a further object of the present invention to provide a beverage brewing apparatus that permits beverage brewing to be carried out with novel combinations of brewing temperatures, pressures and brewing rates thereby resulting in new and improved beverages.

It is a further object of the present invention to provide a beverage brewing apparatus that is adaptable to carry out both high pressure and low pressure beverage brewing.

It is a further object of the present invention to provide a beverage brewing apparatus that produces little or no cross-contamination between successive brewed portions of beverages.

It is further object of the present invention to provide a beverage brewing apparatus that enables beverage brewing with less risk of mess and less solid waste than the apparatus and method of GB-A-2121562.

It is a further object of the present invention to provide methods of brewing beverages using an apparatus according to the invention.

It is a further object of the present invention to provide beverage brewing sachets specifically adapted for use in the apparatus and method of the invention.

The intention is to provide portions of quality, freshly brewed beverages, especially from vending installations and similar equipment.

In a first aspect, the present invention provides an apparatus for the brewing of a beverage by transmission of an aqueous fluid through a sachet containing a beverage brewing ingredient, said apparatus comprising: one or more injectors to inject the aqueous fluid into the sachet during said brewing; and a clamp for the sachet, said clamp comprising one or more members that are movable to open and close the clamp, said members having inner surfaces which in a closed position of the clamp define a cavity adapted to substantially enclose and support the sachet during said brewing and further adapted to define a beverage exit pathway in a lower part of the cavity, and wherein the inner surface of at least one clamp member comprises at least one deformable region that permits the shape of said cavity or said exit pathway to vary while the clamp is in said closed position to provide a desired brewing configuration of the sachet.

The apparatus according to the present invention is preferably adapted for the brewing of individual portions, e.g. cups, of the beverage. For example, the apparatus may form part of a beverage vending installation. The beverage may, for example, be coffee, tea, hot chocolate or soup. Preferably, the beverage is coffee or tea and more preferably the beverage brewing ingredient is ground coffee or leaf tea.

Preferably, the apparatus comprises a heater to supply hot water or steam, preferably hot water at a temperature of preferably 80 to 100°C. Preferably, the apparatus comprises a pump for the aqueous medium, and more preferably the pump can supply the aqueous medium at a pressure of 0.1 to 20 bar gauge, preferably 1 to 15 bar gauge and a rate of 50 to 2000 ml/min, more preferably 60 to 1000 ml/min of hot water.

Details of sachets suitable for use in the apparatus are given below. It is a particular advantage of the present invention that it enables a single apparatus to brew a range of beverages from a single sachet. Alternatively or additionally, the apparatus can accommodate a range of sachet sizes.

It is a characterising feature of this aspect of the present invention that the inner surfaces of the clamp comprise at least one deformable region that permits the shape of the cavity or of the exit pathway to vary after the clamp has been closed so as to conform to a desired brewing configuration of the sachet. That is to say, the configuration of the brewing chamber can be varied even when the clamp is in the closed position. Preferably, the deformable region is adapted to abut directly against and compress a region of the surface of the sachet during brewing. This contrasts with all previous beverage brewing equipment, in which the beverage brewing cavity remains fixed and rigid after assembly of the apparatus. The advantages of having a deformable region include the ability to adapt the cavity to sachets of different sizes, for example for brewing different strengths of beverage with the same amount of brewing liquid. The deformable region also enables pressure to be applied to the sachet, for example to compact a bed of the beverage brewing ingredient in the sachet during brewing. This, of course, is especially useful for brewing espresso-style coffee. Similarly, the ability to deform the brewing cavity in the exit region enables the size of the exit aperture to be controlled, and thereby enables the hydrostatic pressure in the brewing cavity during brewing to be controlled in conjunction with control over the rate of escape of the beverage from the cavity. Suitable control over the exit region shape also enables uncontrolled opening of the sachet to be reduced, thereby reducing the tendency of the beverage to spray onto a user.

The control over the shape of the brewing cavity provided by the deformable region may be static or dynamic. That is to say, the deformable region may be used to preset the shape of the cavity before brewing, and to maintain that shape throughout the brewing step. Alternatively, the shape of the brewing cavity may vary in dynamic fashion during the beverage brewing as described in more detail below.

A particular advantage of the deformable beverage brewing cavity is that it enables the cavity to conform to, and support the beverage brewing sachet enclosed within the cavity, thereby enabling high hydrostatic pressures to be developed inside the sachet without bursting the sachet. Indeed, it is envisaged that the sachet could be formed with very thin walls, thereby reducing the amount of plastic waste material that remains after brewing.

Preferably, the clamp comprises one or more rigid base members, more preferably two such rigid base members, that are movable together in face-to-face or clam-shell fashion to grip the sachet.

The deformable region of the clamp inner surface may be a movable solid region. Preferably, at least the inner surface of the deformable region comprises a material that is conformable but substantially incompressible, preferably a resilient material, such as a layer of elastomer. Typically, the layer of elastomer is from 5 to 25 mm thick and has Shore hardness of from 10 to 60 Shore, preferably from 20 to 50 Shore. Preferably, the deformable layer is constrained by a rigid backing and rigid circumferential edges extending upwardly from the rigid backing around the layer, whereby the layer can support a pressure of 5 to 15 bar on the outer surface of the sachet without excessive deformation. Preferably, the resilient region should extend over the whole part of the inner surface of the clamp that will be in contact with any thin film portion of the sachet. More preferably, a layer of elastomer covers substantially the whole of the inner surface of at least one base member of the clamp that defines the cavity.

Preferably, the inner surface of the layer of elastomer is profiled to conform generally to the shape of the sachet. For example, the inner surface of the layer of elastomer is preferably concave. This enables the layer of elastomer, when a suitable clamping force is applied, to conform accurately to the outer surface of the pressurised sachet and thereby prevent the sachet from bursting. The accurate conformity of the clamp inner surface to the outer surface of the sachet in use also improves beverage brewing quality by reducing the channelling of liquid through the bed of beverage brewing ingredient, since it promotes uniform compression of the beverage brewing ingredient.

Preferably, the clamp has a clam shell configuration, whereby two concave base members are releasably pivoted together in face to face relation to clamp the sachet therebetween. Preferably at least one of the base members has an elastomeric coating over substantially the whole inner surface thereof. Preferably, the base member includes a circumferential wall to enclose the edges of the elastomeric layer to reduce deformation of the layer under pressure. The force exerted on the sachet by the elastomeric coating can be varied, by example by varying the clamping force exerted between the two base members. The clamping force can be fixed at the start of the beverage brewing process, or it may be varied during the beverage brewing where dynamic clamping is desired.

Preferably, at least one layer of elastomer is provided in the exit region of the brewing cavity to pinch the sachet against another clamp member in the exit region and thereby restrict the flow of beverage out of the brewing cavity.

A higher degree of conformability and greater dynamic control over the shape of the brewing cavity and exit region can be achieved where the deformable region comprises a membrane supported on a fluid reservoir. The membrane may be a flexible film, or preferably a flexible layer of elastomer. The fluid reservoir is preferably a liquid reservoir and therefore substantially incompressible. Preferably, the apparatus further comprises a conduit to introduce or remove fluid from the reservoir in order to vary the shape of the cavity during or immediately prior to brewing. Control over the amount of fluid in the reservoir can be achieved,

for example, by including a mechanical or electromechanical valve, or even an electrorheological fluid in the conduit. Preferably, the conduit is connected to a pump or other mechanical or electromechanical driving means for introducing or removing fluid from the cavity. The apparatus may include means to substantially equalising the pressure of a fluid inside the sachet and in the fluid filled reservoir, so as to minimise stress on the wall of the sachet.

A further degree of control over the shape of the brewing cavity can be obtained when the deformable region comprises a plurality of fluid filled reservoirs supporting a plurality of membrane regions. The contents of the plurality of fluid filled reservoirs may be independently controlled. Of course, the inner surface of clamp may comprise, in addition to the one or more deformable regions supported on fluid reservoirs, at least one region of solid elastomer supported on a rigid base part of the clamp. In certain embodiments a fluid-filled reservoir dynamic clamping region may be provided in the exit region of the brewing cavity.

As already noted, it is a feature of the apparatus according to the present invention that it also controls the size and configuration of the beverage fluid exit pathway from the brewing cavity. Preferably, the clamp defines a constriction in the region of the fluid exit, thereby enabling a high brewing pressure to be maintained in the sachet without blowing any part of the sachet or its contents out through the exit pathway. Preferably, the exit region from the brewing chamber comprises clamp members configured to pinch the bottom of the sachet to provide the constriction. More preferably, at least one of the members providing said pinch has a resilient inner surface in said fluid exit region. Preferably, at least one of the members providing said pinch comprises an inner surface with a recess defining a fluid exit pathway through said pinch when the said inner surface is pressed against a complementary inner surface on the clamp to define the exit region. The fluid exit pathway may for example be linear, serpentine or dendritic.

The apparatus preferably comprises a injector tube or tubes for injecting the aqueous fluid into the interior of the sachet when the sachet is held in the brewing cavity. Preferably, the apparatus further comprises a mechanism operatively

associated with the clamp to retract and injector tube or tubes when the clamp is opened. The injector tube may be inserted into a nozzle on the top of the sachet as described in GB-A-2121762. In other preferred embodiments, the injector tube or tubes pierce a side wall of the sachet to inject fluid directly into the interior of the sachet. The injector tube or tubes may project into the brewing cavity at an oblique angle to the exit direction of the beverage cavity, more preferably substantially perpendicularly to exit direction of the beverage cavity.

In a second aspect, the present invention provides a method of brewing a beverage comprising the steps of: providing a sachet formed at least in part from flexible sheet material and containing a beverage brewing ingredient; inserting the sachet into the clamp of an apparatus according to the present invention; and injecting an aqueous fluid into the sachet in the clamp to brew the beverage; and collecting the beverage exiting from the exit pathway of the clamp.

The step of inserting is preferably carried out such that a liquid conduit region provided in the sachet extends through the exit region of the clamp, whereby the beverage exiting the sachet does not contact the clamp. This substantially eliminates cross-contamination between successive brews. Preferably, a lower region of the sachet is gripped or pinched by an exit region of the clamp, whereby the outflow of beverage from the brewing region is restricted.

Preferably the aqueous fluid is injected at a pressure of from 0.1 to 16 bar gauge, more preferably from 1 to 10 bar gauge, and most preferably (for espresso brewing) from 5 to 10 bar gauge. Preferably, the aqueous fluid is injected at a temperature of from 1 to 100°C, more preferably from 80 to 95°C. Preferably, the aqueous fluid consists essentially of water. In particularly preferred processes, the aqueous fluid consists essentially of water at 60 to 100°C, the water is injected at a pressure of from 2 to 10 bar gauge, and the brewing ingredient comprises ground coffee. This enables espresso-type coffee to be produced.

Preferably, the aqueous fluid is injected into the sachet by a peristaltic or piston pump, preferably at an average rate of from 50 to 2000 ml/min and more

preferably 60 to 1000 ml/min. Preferably, the aqueous fluid is injected in intermittent or pulsed fashion to optimise the organoleptic properties of beverage. Preferably, the method further comprises the step of injecting air into the sachet after brewing to expel residual beverage from the sachet.

Preferably, the inner surface of the clamp in the brewing apparatus comprises at least one movable region, and the method further comprises moving the said region in order to compress the brewing ingredient in the sachet.

Preferably, the inner surface of the clamp comprises at least one movable region, and the method further comprises moving the region during brewing in order to vary the configuration of the sachet during brewing. This enables the beverage quality to be optimised, and also permits the brewing of completely new beverage types, for example beverages having part-espresso and part-filter coffee characteristics.

Preferably, the inner surface of the clamp comprises at least one movable region, and the method further comprises moving the region in order to compress the sachet and squeeze out any remaining beverage from the sachet after brewing is complete.

Preferably, the inner surface of the clamp in the exit region of the clamp comprises at least one movable region, and the method further comprises moving the said region before, during or after brewing in order to regulate the rate of flow of the beverage out of the cavity and the fluid pressure maintained inside the cavity by regulating the effective cross-section of the exit region.

Preferably, the inner surface of the clamp comprises at least one movable region, and the method further comprises oscillating the movable region during brewing to agitate the beverage brewing ingredient.

Preferably, in all of the above embodiments, the movable region comprises a flexible membrane supported on a fluid-filled reservoir, whereby the region can

be moved by pumping fluid into or out of the reservoir. However, the invention also encompasses movable regions that are movable by mechanical or electromechanical means.

The term "sachet" as used in this specification refers to any portion pack containing a predetermined quantity of a beverage brewing ingredient, including capsules comprising one or more rigid wall members. Preferably, the sachet comprises at least one region formed from a flexible film material to permit deformation of the sachet in response to externally applied pressure. More preferably, the sachet comprises a pouch formed from flexible film material, for example a pouch manufactured on form/fill/seal equipment . Preferably, the sachet is formed from substantially air- and moisture-impermeable material so as to maintain the freshness of the beverage brewing ingredient during storage before use. In certain preferred embodiments, the sachet may comprise an injection nozzle in an upper region thereof, into which an injector is inserted in use. Preferably, the sachet comprises a region of weakness that opens in response to water, heat and/or pressure within the sachet to release the beverage brewed inside the sachet. For example, the region of weakness may be formed in the bottom of the sachet as described in GB-A-2121762. In certain embodiments the region of weakness may comprise a sealant that is released by the action of heat and/or moisture, such as an adhesive as described in EP-A-0179641 or WO99/05036. In other embodiments, the apparatus may comprise means to cut or pierce an exit region of the sachet before brewing.

In certain embodiments the sachet may contain a compressed bed of coffee, for example a vacuum-packed bed of coffee or a compressed tablet of coffee. The sachet may also contain a filter element, such as a filter paper extending across the sachet below the beverage brewing ingredient, for example as described in EP-A-0179641.

Preferably, the sachet contains an individual portion of the beverage brewing ingredient, for example from 2gm to 12gm of ground coffee or from 1gm to 5gm of leaf tea.

In a further aspect, the present invention provides a beverage brewing sachet comprising front and back faces of sheet material joined together to define a brewing space containing a beverage brewing ingredient, and further comprising a liquid guide joined to said brewing region and extending outside the brewing region in a bottom part of the sachet.

Preferably, the liquid guide extends for a distance of at least 10mm outside the brewing space in a bottom part of the sachet, more preferably at least 15mm, still more preferably at least 20 mm or 25 mm.

In certain preferred embodiments, the liquid guide comprises an extension of at least one of the sheets of material that form the brewing region of the sachet. More preferably, the sachet comprises an extension of both of the sheets of material that form the brewing region of the sachet in face to face relationship to define the liquid guide therebetween. In certain embodiments, the liquid guide is formed at least in part by one or more conduits impressed into the sheet material of the sachet. In other embodiments the guide may comprise a solid capillary or a thermoformed recess.

In certain preferred embodiments, the sachet comprises a filter for the beverage brewing ingredient located between the brewing ingredient and the liquid guide.

In certain preferred embodiments, the sachet comprises comprises an air-tight seal located between the brewing space and the liquid guide, wherein said seal is releasable by the action of heat, pressure and/or water in the brewing space during brewing. For example, the seal may be an EVA adhesive seal between the front and back sheets of the sachet.

Preferably, the liquid guide terminates in one or more drip-forming points, whereby the beverage is directed into a cup.

Preferably, the sachet is specifically adapted for use in a beverage brewing apparatus according to the present invention, more preferably in a brewing method according to the present invention.

In a further aspect, the present invention provides a method of brewing a beverage comprising the steps of: providing a sachet comprising front and back layers of sheet material joined together to define a brewing space containing a beverage brewing ingredient; providing a beverage brewing apparatus comprising one or more injectors to inject aqueous fluid into the sachet during said brewing and a clamp for the sachet, said clamp comprising one or more members that are movable to open and close the clamp, said clamp having inner surfaces which in a closed position of the clamp define a cavity adapted to substantially enclose the sachet during the brewing and further adapted to define a beverage exit pathway in a lower part of the cavity; inserting said sachet into said cavity of the clamp with a liquid exit portion of the sachet extending through the beverage exit pathway; injecting an aqueous fluid into the sachet through the injector to brew a beverage in the brewing space of the sachet; and allowing the beverage to escape from the sachet through the liquid exit portion; wherein the beverage escapes through the liquid exit portion substantially without contacting the clamp in the region of the beverage exit pathway.

Preferably, the sachet is a sachet according to the present invention having a liquid guide joined to the brewing region.

In certain preferred embodiments, the apparatus constricts the sachet in the exit region during said brewing. For example, the apparatus may pinch the sachet in the exit region.

Specific embodiments of the present invention will now be described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a schematic cross-section through a first embodiment of the invention having static, elastomeric clamp surfaces;

Figure 2 shows a partial cross-section through the embodiment of Figure 2 with the clamp in the closed, brewing configuration;

Figure 3 shows a schematic cross-section through a second embodiment of the invention having one static clamp face and one dynamic clamp face;

Figure 4 shows a schematic perspective view, partially cut away, of a third embodiment of the invention having multiple, movable regions in each clamp face; and

Figure 5 shows a top plan view of a beverage brewing sachet after brewing in an apparatus according to a further embodiment of the invention, showing a beverage exit manifold formed by deformation of the sachet in the exit region.

Referring to Figure 1 the apparatus comprises rigid metal base members 1, 2 that are clamped together in face-to-face relation by a clamping mechanism (not shown). The clamping force can be adjusted to provide the desired compression of the coffee in the brewing cavity.

Each base member 1, 2 is lined with a layer of silicone elastomer 3, an inner surface of which is slightly concave to define the brewing cavity. The elastomer is a silicone elastomer having a Shore hardness of about 40.

A beverage brewing sachet 4 is received in the cavity between the two clamp portions. The construction of the sachet 4 is substantially similar to the sachets described in EP-A-0179641. That is to say, the sachet is formed from two sheets of air- and moisture-impermeable plastic film material 5 bonded together around their periphery. A plastic nozzle 6 is inserted in the top edge of the sachet, and a bottom seal 7 of the sachet is made by bonding together the front and back sheets of the sachet with a sealant resin that is released by the action of

heat and moisture during brewing. The bottom ends 8 of the thermoplastic sheets 5 project through the exit region of the clamp, and function as a conduit to guide beverage out of the clamp.

The sachet is filled with ground coffee 9, and this coffee bed is tightly compressed by the action of the clamp. The sachet may contain a filter paper proximate to the exit region of the sachet as described in EP-A-0179641. However, in this particular embodiment such a filter paper is not necessary, because the tightly packed ground coffee bed functions as its own filter in conjunction with the pinch applied to the bottom of the sachet by the shaped elastomeric clamps.

In use, the apparatus may be used to brew espresso coffee by clamping the sachet tightly between the elastomeric clamps, and then injecting water at temperature of about 90°C at a pressure of typically 5 to 20 bar, preferably 10 to 15 bar in continuous or pulsed mode to brew the espresso. The elastomeric clamps maintain the desired pressure in the coffee bed for espresso brewing. Furthermore, the pinch applied to the exit region of the sachet by the elastomeric clamps prevents the water pressure from blowing out the coffee grounds from the sachet. Finally, the conformability of the elastomeric clamps supports the walls of the sachet against bursting, and reduces channelling of the water through sides of the coffee bed.

The apparatus of Figure 1 can be adapted for brewing filter coffee simply by clamping the sachet less tightly so that the coffee bed in the sachet is not under compression during brewing, and by injecting a larger amount of water relative to the amount of coffee in the sachet. The walls of the sachet are preferably still supported by the elastomeric clamp, so as to reduce the risk that the sachet will burst and to optimise the shape of the brewing cavity.

Referring to Figure 2, this embodiment of the apparatus and method according to the invention uses a brewing clamp comprising a first, rigid piece 12 and a second, conformable piece 13. Three hollow needle injectors 14 extend

through the rigid clamp piece 12 and pierce a first face 15 of beverage brewing sachet 16. The sachet 16 contains a compressed bed of coffee 17. The variable configuration clamp 13 comprises a rigid base member 18 and a fluid reservoir 19 supporting an elastomeric membrane 20. The fluid reservoir 19 enables the elastomeric membrane 20 to conform to the top surface 21 of the capsule or sachet 16. The clamping pressure applied to the sachet 16 can be regulated by varying the clamping force between the clamp elements 12 and 13, and also by varying the liquid pressure in the reservoir 19.

The sachet 16 includes a liquid conduit region 22 that extends through and beyond the exit region of the clamp, and through which the brewed beverage passes thereby preventing contamination of the clamp by the brewed beverage and cross-contamination between beverages brewed from successive sachets.

In use, the clamp according to this aspect of the invention operates substantially in the same fashion as the clamp of Figure 1, but offers the additional advantage that dynamic clamping effects can be achieved by pumping liquid into and out of the reservoir 19 during brewing. For example, the pressure on the cavity could be reduced during brewing to achieve a transition from espresso-style brewing to filter-type coffee brewing in a single brewing operation. Alternatively, the amount of fluid in the reservoir could be oscillated to agitate the bed of coffee in the sachet during brewing. Preferably, additional fluid is pumped into the reservoir at the end of the brewing operation in order to squeeze as much beverage as possible from the sachet. This is assisted by injecting air into the sachet through the injectors 14 after brewing to expel the remaining beverage.

The injector hollow needles may be coupled to the clamp so that they retract when the clamp is opened in order to avoid any risk of injury to the user.

Referring to Figure 3, the alternative embodiment shown in the drawing includes a rigid clamp element 30 and a conformable clamp element 31. The conformable element 31 has a first region facing the beverage brewing cavity that has an elastomeric membrane supported on a liquid reservoir substantially similar

to the embodiment of Figure 2. However, the liquid reservoir 32 is filled with an electrorheological fluid, and the pressure in the reservoir 32 is regulated by means of electrodes 33 disposed on either side of a conduit 34 leading to electrorheological reservoir 35.

A lower part of the conformable clamp element is covered with a layer of solid elastomer 36.

The rigid clamp element 30 includes a recess 38 for insertion of a water injection hollow needle, and a recess shaped to receive a sachet 39 including a nozzle 40. Shallow recesses 41 are provided in the bottom, beverage exit region of clamp element 30 to define the conduits for beverage exit from the brewing cavity when the rigid clamp element 30 is in abutment with the solid elastomeric region 36 of the conformable clamp element 31.

Referring to Figure 4, the embodiments shown therein resembles the embodiment of Figure 1, but with the solid elastomeric linings of Figure 1 replaced by an elastomeric membrane 43 supported on four fluid filled chambers 44, 45, 46 and 47. Each of the fluid filled chambers is independently connected through a conduit to valve and pump means for controlling the volume and pressure of fluid in the chambers 44, 45, 46 or 47 independently. This opens up further possibilities for dynamic clamping of the sachet during brewing, in particular to regulate the flow rate of beverage through the exit region by lowering the pressure in the cavity 47, or to agitate the contents of the sachet by oscillating or peristaltic pumping of the membrane 43.

Referring to Figure 5, the used sachet shown in the drawing comprises front and back faces of air- and water-impermeable sheet material formed from a layer of metal foil laminated beween two thermoplastic films. The sheets are bonded together around edges 50 to form an air-tight seal around the beverage brewing ingredient. The bonding seal in the lower part of the sachet is formed from an EVA adhesive that is released by the action of water, heat and pressure inside the cavity when the beverage is being brewed, to allow the beverage to escape from

the brewing region. A plastic nozzle similar to that shown in Figure 1 is inserted into the top edge of the sachet. The bottom edge of the sachet includes projecting tongues 52 of the sheet material in face-to-face configuration that guide liquid beverage out of the sachet, and that terminate in drip point 53. The side edges of the tongue may be bonded together to convert the tongue into a tubular conduit.

The sachet shown in Figure 5 has been brewed in an apparatus similar to that shown in Figure 3. In particular, a lower region 54 of the sachet has been pinched between a solid elastomeric member and a rigid, flat surface having a manifold of recesses indented therein, whereby a complementary dendritic manifold of recesses 55 has been impressed in the sheet material of the sachet. These recesses 55 act as conduits for the beverage from the brewing region of the sachet to define a part of the liquid conduit region of the sachet. Appropriately sized and configured impressed conduits provide control over the rate of escape of beverage from the brewing region and thereby enable optimised brewing, especially when the brewing is being carried out at elevated pressure in the brewing cavity.

The above embodiments of the present invention have been described by way of example only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

CLAIMS

1. An apparatus for the brewing of a beverage by transmission of an aqueous fluid through a sachet containing a beverage brewing ingredient, said apparatus comprising:

one or more injectors to inject the aqueous fluid into the sachet during said brewing; and

a clamp for the sachet, said clamp comprising one or more members that are movable to open and close the clamp, said members having inner surfaces which in a closed position of the clamp define a cavity adapted to substantially enclose and support the sachet during said brewing and further adapted to define a beverage exit pathway in a lower part of the cavity, and

wherein the inner surface of at least one clamp member comprises at least one deformable region that permits the shape of said cavity or said exit pathway to vary while the clamp is in said closed position to provide a desired brewing configuration of the sachet.

2. An apparatus according to claim 1, wherein the deformable region is formed from substantially incompressible material.

3. An apparatus according to claim 1 or 2, wherein the deformable region comprises a resilient region.

4. An apparatus according to claim 3, wherein the resilient region comprises a layer of elastomer.

5. An apparatus according to claim 4, wherein the layer of elastomer covers substantially the whole of an inner surface of at least one of said clamp members.

6. An apparatus according to claim 4 or 5, wherein the inner surface of the layer of elastomer is profiled to conform generally to the shape of the sachet.

7. An apparatus according to any preceding claim, wherein the deformable region is supported on a rigid base member of the clamp.

8. An apparatus according to claim 7, wherein the deformable region is constrained by a rigid wall member extending upwardly from the rigid base member around an edge of the deformable region.

9. An apparatus according to claim 4, 5 or 6, wherein the Shore hardness of the elastomer layer is from 10 to 60 Shore.

10. An apparatus according to claim 4, 5 or 6, wherein the thickness of the solid elastomer layer is from 5 to 25 mm.

11. An apparatus according to any one of claims 1 to 10, wherein the deformable regions comprise a membrane supported on a fluid reservoir.

12. An apparatus according to claim 11, wherein the apparatus further comprises a conduit to introduce or remove fluid from the reservoir in order to vary the shape of the cavity during or immediately prior to brewing.

13. An apparatus according to claim 10, wherein the conduit contains an electro-rheological fluid or a mechanical or electromechanical valve.

14. An apparatus according to claim 12 or 13, wherein the conduit is connected to a pump or other mechanical or electromechanical driving means for introducing or removing fluid from the cavity.

15. An apparatus according to any one of claims 12 to 14, wherein the deformable region comprises a plurality of fluid filled reservoirs supporting a plurality of membrane regions.

16. An apparatus according to any one of claims 11 to 15, wherein the inner surface of the clamp comprises, in addition to said deformable region supported

on a fluid reservoir, at least one region of solid elastomer supported on a rigid base.

17. An apparatus according to any preceding claim, wherein said exit region from the brewing chamber comprises at least one clamp member configured to pinch the bottom of the sachet.

18. An apparatus according to claim 17, wherein at least one of the members providing said pinch has a resilient inner surface in said fluid exit region.

19. An apparatus according to claim 17 or 18, wherein at least one of the members providing said pinch comprises an inner surface with a recess defining a fluid exit pathway through said pinch.

20. An apparatus according to any preceding claim, wherein the clamp comprises two members that are movable together in face-to-face relationship to form said cavity.

21. An apparatus according to any preceding claim, further comprising a mechanism operatively associated with the clamp to retract the injector when the clamp is opened.

22. An apparatus according to any preceding claim, wherein the injector comprises a hollow needle that projects into said cavity at an oblique angle to the exit direction of the beverage from the cavity.

23. An apparatus according to claim 22, wherein the hollow needle projects into said cavity substantially perpendicularly to the exit direction of the beverage from the cavity.

24. A method of brewing a beverage comprising the steps of:

providing a sachet formed at least in part from flexible film material and containing a beverage brewing ingredient;

inserting the sachet into the clamp of an apparatus according to any one of claims 1 to 23;

injecting an aqueous fluid into the sachet in said clamp to brew the beverage; and

collecting the beverage exiting from the exit pathway of the clamp.

25. A method according to claim 24, wherein the step of inserting is carried out such that a liquid exit portion of the sachet extends through the exit region of the clamp, whereby the beverage exiting the sachet does not contact the clamp.

26. A method according to claim 25, wherein said clamp constricts said liquid exit portion of said sachet during said brewing.

27. A method according to claim 24, 25 or 26, wherein the aqueous fluid is injected at a pressure of from 0.1 to 16 bar gauge.

28. A method according to claim 27, wherein the aqueous fluid is injected at a pressure of from 5 to 15 bar gauge.

29. A method according to any one of claims 24 to 28, wherein the aqueous fluid is injected at a temperature of from 1 to 100°C.

30. A method according to claim 29, wherein the aqueous fluid is injected at a temperature of from 85 to 95°C.

31. A method according to any one of claims 24 to 30, wherein the aqueous fluid consists essentially of water.

32. A method according to any one of claims 24 to 31, wherein the aqueous fluid consists essentially of water at 80 to 100°C, the water is injected at a pressure of from 2 to 16 bar gauge, and the brewing ingredient comprises ground coffee, whereby the beverage is an espresso-type coffee.

33. A method according to any one of claims 24 to 32, further comprising the step of injecting air into the sachet after brewing to expel residual beverage from the sachet.

34. A method according to any one of claims 24 to 33, wherein the inner surface of the clamp defining the brewing cavity comprises at least one movable region, and the method further comprises moving said region inwardly before brewing in order to compress the brewing ingredient in the sachet.

35. A method according to any one of claims 24 to 34, wherein the inner surface of the clamp defining the brewing cavity comprises at least one movable region, and the method further comprises moving said region during brewing in order to vary the configuration of the sachet during brewing.

36. A method according to claim 35, wherein the method comprises oscillating said region during brewing.

37. A method according to any one of claims 24 to 36, wherein the inner surface of the clamp defining the brewing cavity comprises at least one movable region, and the method further comprises moving said region inwardly after brewing in order to compress the sachet and squeeze out residual beverage from the sachet.

38. A method according to any one of claims 24 to 37, wherein the inner surface of the clamp defining the exit region comprises at least one movable region, and the method further comprises moving said region before, during or after brewing in order to regulate the rate of flow of the beverage out of the cavity and/or to control the fluid pressure inside the cavity.

39. A method according to any one of claims 24 to 38, wherein the aqueous fluid is injected through a hollow tube directed at an oblique angle, preferably substantially perpendicular, to the direction that the beverage exits from the cavity.

40. A beverage brewing sachet comprising front and back faces of sheet material joined together to define a brewing space containing a beverage brewing ingredient, and further comprising a liquid guide joined to said brewing region and extending outside the brewing region in a bottom part of the sachet.

41. A beverage sachet according to claim 40, wherein the liquid guide extends for a distance of at least 10mm outside the brewing space in a bottom part of the sachet.

42. A beverage sachet according to claim 40 or 41, wherein the liquid guide comprises an extension of at least one of the sheets of material that form the brewing region of the sachet.

43. A beverage sachet according to claim 40, 41 or 42, wherein the liquid guide comprises an extension of both of the sheets of material that form the brewing region of the sachet in face to face relationship to define the liquid guide therebetween.

44. A beverage sachet according to any one of claims 40 to 43, wherein the liquid guide is formed at least in part by one or more conduits impressed into the sheet material of the sachet.

45. A beverage sachet according to any one of claims 40 to 44, further comprising a filter for the beverage brewing ingredient located between the brewing ingredient and the liquid guide.

46. A beverage sachet according to any one of claims 40 to 45, further comprising an air-tight seal located between the brewing space and the liquid guide, wherein said seal is releasable by the action of heat, pressure and/or water in the brewing space during brewing.

47. A beverage sachet according to any one of claims 40 to 46, wherein the liquid guide terminates in one or more drip-forming points.

48. A beverage sachet according to any one of claims 40 to 47, wherein the sachet is adapted for use in a beverage brewing apparatus according to any one of claims 1 to 21

49. A method of brewing a beverage comprising the steps of:

providing a sachet comprising front and back layers of sheet material joined together to define a brewing space containing a beverage brewing ingredient;

providing a beverage brewing apparatus comprising one or more injectors to inject aqueous fluid into the sachet during said brewing and a clamp for the sachet, said clamp comprising one or more members that are movable to open and close the clamp, said clamp having inner surfaces which in a closed position of the clamp define a cavity adapted to substantially enclose the sachet during the brewing and further adapted to define a beverage exit pathway in a lower part of the cavity;

inserting said sachet into said cavity of the clamp with a liquid exit portion of the sachet extending through the beverage exit pathway;

injecting an aqueous fluid into the sachet through the injector to brew a beverage in the brewing space of the sachet; and

allowing the beverage to escape from the sachet through the liquid exit portion, wherein the beverage escapes through the liquid exit portion substantially without contacting the clamp in the region of the beverage exit pathway.

50. A method of brewing a beverage according to claim 49, wherein said apparatus constricts said sachet in said exit region during said brewing.

51. A method of brewing a beverage according to claim 49 or 50, wherein said sachet is a sachet having a liquid guide according to any one of claims 40 to 48.

52. A method of brewing a beverage according to any one of claims 49 to 51, wherein said apparatus is an apparatus in accordance with any one of claims 1 to 23.

53. A method of brewing a beverage according to claim 52, wherein said method is a method in accordance with any one of claims 24 to 39.

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